Cal/Ecotox
Exposure Factors for Kit Fox (Vulpes macrotis)*

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Age at Sexual Maturity	22			mo	B	Adult	Kern; CA	a	1
Body Weight - Mean	1820			g	B	Adult	AZ	b	2
Body Weight - Mean			4.4-5.6	lbs	F	Adult	Kern; CA	c	3
Body Weight - Mean	1936	64 SE		g	F	Adult	Kern; CA	d	4
Body Weight - Mean	4.2		3.6-4.6	lbs	F	Adult	UT	e	5
Body Weight - Mean			3.8-5.5	lbs	M	Adult	Kern; CA	f	3
Body Weight - Mean	2034	78 SE		g	M	Adult	Kern; CA	g	4
Body Weight - Mean	4.55		3.8-5.5	lbs	M	Adult	UT	h	5
Clutch or Litter Size			3-5	pups	F	Adult	Kern; CA	i	3
Clutch or Litter Size	2.5		2-4	pups	F	Adult	UT	j	6
Clutch or Litter Size			2.75-5	pups	F	Adult	UT	k	7
Clutch or Litter Size	4.1			pups	F	Adult	Kern; CA	l	1
Clutch or Litter Size			1-3	pups	F	Adult	San Luis Obispo; CA	m	8
Clutch or Litter Size			4-5	pups/litter	F	Adult	UT	n	5
Dietary Composition	black-tailed hare (61.4%), cottontail rabbit (7.7%); also Ord's kangaroo rat, deer mouse, pocket mouse, horned lark, unident. passerine, beetle				B	Adult	UT	o	6
Dietary Composition	deer mice (10.8%), kangaroo rats (8.4%), pocket gophers (2.9%), pocket mice (20.0%), woodrats (0.6%), ground squirrels (6.4%), birds (7.5%), insects (33.5%), leporids (4.7%), reptiles (2.0%),			%	B	Adult	San Luis Obispo; CA	p	9
Dietary Composition	insects (1.3%), Hermann's kangaroo rat (19.6%), California vole (31.5%), deer mouse (14.4%), California ground squirrel (24.4%), Audubon's cottontail (12.0%), unident. plant material (0.7%)			%	B	Both Adult and Juv.	Merced; CA	q	10
Dietary Composition	Spermophilus beecheyi (35%), soluble material (16.6%), grasshoppers/crickets (12.9%), lagomorphs (12.2%), kangaroo rats (9.1%), miscellaneous (10.2%), deer mice/wood rats (7.7%), birds (5.2%), beetles/weevils (3.5%), vegetation (2.8%), snakes (2.0%), pocket mice (0.8%), pocket gophers (0.5%), lizards (0.2%)			%	B	Both Adult and Juv.	Monterey; San Luis Obispo; CA	r	11
Dietary Composition	lagomorphs (73.3%), kangaroo rats (13.1%), San Joaquin antelope ground squirrel (2.9%), San Joaquin kit fox (2.8%), Cricetidinae (1.3%), Heteromyidae (0.8%), San Joaquin pocket mouse (0.7%), California ground squirrel (0.6%), southern grasshopper mouse (0.5%), sheep (0.5%), Botta pocket gopher (0.3%), birds (1.4%), snakes (1.2%), lizards (0.1%),			%	B	Both Adult and Juv.	Kern; CA	s	12

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Dietary Composition	grasshoppers and crickets (6.2%), beetles (1.0%), arthropods (0.2%), grass (1.7%), soluble material (5.2%), other (9.1%)								
Dietary Composition	Kangaroo rats (80.7%), rabbits (46.2%), squirrels (9.6%), cottontails (5.8%), pocket mouse (1.9%), unident. insects (59.6%), scorpions (17.3%), Jerusalem crickets (13.5%), insect larvae (11.5%), ants (9.6%), grasshoppers (5.8%), beetles (3.8%), spiders (1.9%)			%	B	NR	Kern; CA	t	3
Dietary Composition	Jerusalem crickets (27%), unident. birds (2%), rabbits (3%), California ground squirrel (35%), pocket mice (2%), western harvest mice (17%), Peromyscus sp. (13%)			%	B	NR	Alameda; CA	u	13
Dietary Composition	Jerusalem crickets (1%), unident. reptiles (1%), unident. birds (1%), rabbits (5%), California ground squirrel (62%), pocket mice (5%), western harvest mice (10%), Peromyscus sp. (11%)			%	B	NR	Alameda; CA	v	13
Dietary Composition	Jerusalem crickets (20%), unident. insects (4%), unident. birds (10%), desert cottontail (1%), rabbits (5%), California ground squirrel (27%), pocket mice (13%), western harvest mice (9%), Peromyscus sp. (9%), unident. cricetid rodents (5%)			%	B	NR	Alameda; CA	w	13
Dietary Composition	unident. vegetation (4%), California ground squirrel (83%), California pocket mice (2%), Peromyscus sp. (5%), unident. cricetid rodents (5%)			%	B	NR	Alameda; CA	x	13
Dietary Composition	Review				NR	NR	CA	y	14
Dietary Composition	human derived food items (12.2%), ground squirrel (67.8%), pocket gopher (3.9%), unident. rodent (5.0%), leporid (5.0%), bird (12.2%), insect (23.3%), other (2.2%)			%	NR	NR	Kern; CA	z	15
Dietary Composition	Dipodomus ingens (17%), Dipodomys sp. (14%), D. heermanni (10%), Unident. rodents (6%), Oedaleonotus enigma (66%), Pocalta ursinus (5%), Coniontis sp. (1%), Stenopelmatus (9%), grass (74%)			%	NR	NR	San Benito; CA	aa	16

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Dietary Composition	see figure				NR	NR	Kern; CA	ab	17
Food Ingestion Rate	115			g/d	B	Adult	Lab	ac	18
Food Ingestion Rate	101			g/d	B	Adult	Lab	ad	18
Food Ingestion Rate	175		108-348 (male); 56-292 (female)	g/day	B	Adult	Lab	ae	5
Growth Rate			0.75-1	lb/month	B	Pup	Kern; CA	af	3
Home Range			1-2	mi2	B	Adult	Kern; CA	ag	3
Home Range	1.61	0.20 SE		km2	B	Adult	Kern; CA	ah	19
Home Range	5.82	0.45 SE		km2	B	Adult	Kern; CA	ai	19
Home Range	6.13	0.45 SE	1.69-11.18	km2	B	Adult	Kern; CA	aj	19
Home Range	200			ha	B	Adult	Kern; CA	ak	4
Home Range	11.6	0.9 SE		km2	B	Adult	San Luis Obispo; CA	al	8
Home Range	1.9	1.2 SD		km2	F	Adult	UT	am	20
Home Range	1.4	0.7 SD		km2	F	Adult	UT	an	20
Home Range	9.8	0.1.4 SE		km2	F	Adult	AZ	ao	21
Home Range	4.2	1.5 SD		km2	M	Adult	UT	ap	20
Home Range	1.9	1.1 SD		km2	M	Adult	UT	aq	20
Home Range	12.3	1.0 SE		km2	M	Adult	AZ	ar	21
Home Range	4.3			km2	B	Both Adult and Juv.	Kern; CA	as	22
Longevity	5+		4-7	yr	B	Adult	UT	at	7
Longevity	2.4	0.7 SE		mo	B	Adult	Kern; CA	au	4
Longevity	10.2	0.8 SE	8-14	mo	B	Adult	Kern; CA	av	4
Metabolic Rate	0.0034			watts/g	B	Adult	Lab	aw	2
Metabolic Rate	0.0028			watts/g	B	Adult	Lab	ax	2
Population Density	1			fox/2.8 mi2	B	Adult	Kern; CA	ay	14
Population Density	1			adult/12.9 km^2	B	Adult	UT	az	6
Population Density	4		1-5	pairs/207 km^2	B	Adult	UT	ba	6
Population Density			470.9-1035.9	ha/fox	B	Adult	UT	bb	7
Population Density			2-2.8	#/260 ha	B	Adult	Kern; CA	bc	1
Population Density			1	den/28 ha - 1 den/37 ha	B	Adult	Kern; CA	bd	1
Population Density			1	fox /4.1 km2 - 1 fox / 6.5 km2	B	Adult	San Luis Obispo; CA	be	8
Population Density	3.6			pairs/square mile	B	Adult	UT	bf	23
Population Density	see citation				B	Both Adult and Juv.	Kern; San Luis Obispo; CA	bg	24
Population Density	review			#/km2	NR	NR		bh	25
Survival/ Mortality	67			%	B	Adult	Alameda; CA	bi	13
Survival/ Mortality			0.27-0.86		F	Adult	Kern; CA	bj	26
Survival/ Mortality			0.55-0.57		M	Adult	Kern; CA	bk	26
Survival/ Mortality	61.0	5.2 SE	30.0-84.0	%	NR	Adult	Kern; CA	bl	17
Survival/ Mortality	review				NR	Adult		bm	25

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Survival/ Mortality			0.4-.63		B	Both Adult and Juv.	Kern; CA	bn	26
Survival/ Mortality	80			%	B	Juvenile	Alameda; CA	bo	13
Survival/ Mortality	79.8	4.5 SE	50.0-100	%	NR	Juvenile	Kern; CA	bp	17
Time of Hatching or Parturition	February-March				F	Adult	Kern; CA	bq	3
Time of Hatching or Parturition	early February				F	Adult	Kern; CA	br	1
Time of Hatching or Parturition	March to early April				F	Adult	UT	bs	23
Time of Mating/ Laying	December				B	Adult	Kern; CA	bt	1
Time of Mating/ Laying	January				B	Adult	Kern; CA	bu	4
Time of Migration or Dispersal	late summer				B	Juvenile	UT	bv	7

Notes

a N=NR; Elk Hills Naval and Buena Vista Petroleum Reserves
b mean annual body weight; N=20 foxes
c range of monthly averages (Jan.-Dec.); N=1-5 foxes/month; Buena Vista Valley
d N=13 foxes; Rand Open Area and Desert Tortoise Research Natural Area
e average body weight; N=6; Tooele County, west. UT
f range of monthly averages (Jan.-Dec.); N=1-4 foxes/month; Buena Vista Valley
g N=15 foxes; Rand Open Area and Desert Tortoise Research Natural Area
h mean body weight; N=10; all; Tooele County, west. UT
i N=5 litters; Buena Vista Valley
j mean litter size; N=8 litters
k range of mean litter sizes over four years; N=2-6 litters/year; western Utah
l mean litter size; N=NR; Elk Hills Naval and Buena Vista Petroleum Reserves
m N=4 foxes; Carrizo Plain Natural Area; 4 of 7 observed females produced pups
n N=11 litters; spring; Tooele County, west. UT
o proportion of total prey items identified in stomach contents; N=18 stomachs
p percentage occurrence of prey types in feces; N=834 feces; Carrizo Plain Natural Area; relative rankings of prey types did not change seasonally
q relative composition of prey remains in scat; N=25 scats; Kesterson National Wildlife Refuge
r frequency of occurrence of prey items found in scat; N=649 scats; year round; Camp Roberts
s frequency of occurrence of food items found in scat; N=1430 scats; year round; Naval Petroleum Reserve #1
t frequency of occurrence in scat analyses; N=52 scat groups; various plant species also found in most scat
u percent volume of total prey items in scat; N=10 scats; winter; Bethany Reservoir
v percent volume of total prey items in scat; N=10 scats; spring; Bethany Reservoir
w percent volume of total prey items in scat; N=10 scats; fall; Bethany Reservoir
x percent volume of total prey items in scat; N=10 scats; summer; Bethany Reservoir
y N=NR
z frequency of occurrence in scats; N=180 scats; fall; Bakersfield, CA
aa Percent occurrence in scats; N=74 scats (1 den); July; 6 mi. east of Panoche
ab bar graph showing use of leporids, rodents, insects and other food items over 6 years; N=449 scat samples; Naval Petroleum Reserves in California
ac estimated daily food intake based on a desert kangaroo diet (7.38 kJ/g wet wt) and calculated daily energy requirements (see Golightly, 1981); N=NR; summer
ad estimated daily food intake based on a desert kangaroo diet (7.38 kJ/g wet wt) and calculated daily energy requirements (see Golightly, 1981); N=NR; winter
ae average daily consumption in captivity; N=NR; Tooele County, west. UT; Food was provided ad libidum.
af growth rate observed in repeatedly trapped pups; N=NR; Buena Vista Valley; adult weight reached at 5 months of age
ag approximate range of individual foxes; N=12 foxes; Buena Vista Valley
ah denning range, based on observations of marked individuals at dens; N=26; south San Joaquin Valley
ai nocturnal range, based on noctural locations of marked individuals; N=26; south San Joaquin Valley
aj based on all observations of marked individuals

ak	denning range (area enclosing occupied den sites); N=16 foxes; Rand Open Area and Desert Tortoise Research Natural Area
al	individual home range size; N=21 foxes; Carrizo Plain Natural Area
am	calculated with Minimum Area Method; N=4; winter; Pine Valley
an	calculated with Minimum Area Method; N=4; summer; Pine Valley
ao	home range as calculated with the grid-cell method; N=3 foxes; 7.5 km NW Tonopah
ap	calculated with Minimum Area Method; N=5; winter; Pine Valley
aq	calculated with Minimum Area Method; N=4; summer; Pine Valley
ar	home range as calculated with the grid-cell method; N=4 foxes; 7.5 km NW Tonopah
as	average home range; N=NR; Naval Petroleum Reserves in California, Bakersfield
at	average maximum age attained; N=NR; western Utah
au	measured from time of capture to time of last capture or radio-telemetry location; N=13 foxes; Rand Open Area and Desert Tortoise Research Natural Area; data for study area with minimal human disturbance
av	measured from time of capture to time of last capture or radio-telemetry location; N=6 foxes; Rand Open Area and Desert Tortoise Research Natural Area; data for area with high human disturbance
aw	summer basal metabolic rate; N=12 foxes; summer; see paper for figures showing oxygen consumption rates at various ambient temperatures
ax	winter basal metabolic rate; N=12 foxes; winter; see paper for figures showing oxygen consumption rates at various ambient temperatures
ay	estimated average density based on censuses and literature values; N=108 dens
az	mean animal density in study area; N=NR
ba	mean number of pairs on study area; N=NR
bb	population density on 10,359.9 ha study area; N=foxes 9-22; western Utah
bc	adult density; N=361 foxes; Elk Hills Naval and Buena Vista Petroleum Reserves
bd	denning density; N=1010 dens; Elk Hills Naval and Buena Vista Petroleum Reserves
be	minimum densities of foxes in study area over three years; N=15-22 foxes/year; Carrizo Plain Natural Area
bf	N=9 individuals; spring; Tooele County, west. UT, elev. 4300-4800 ft
bg	figures showing seasonal abundance and density counts; N=1,239 surveys (dry season); 883 surveys (wet season)
bh	N=NR; reported values range from 0.14-1.57 #/km2
bi	N=3 foxes; Bethany Reservoir
bj	Survival rates of radiocollared foxes for 1990, 1991; N=32 foxes; all; extreme southern San Joaquin Valley
bk	Survival rates of radiocollared foxes for 1990, 1991; N=25 foxes; all; extreme southern San Joaquin Valley
bl	mean annual mortality rate over 13 years; N=306 foxes; Naval Petroleum Reserves in California
bm	N=NR; survival rates range from 0.35 - 0.75
bn	Survival rates of radiocollared foxes for 1990, 1991; N=57 foxes; all; extreme southern San Joaquin Valley; highest mortality observed in fall (Sept.-Dec.); predation accounted for 64% of all mortality
bo	N=5 foxes; Bethany Reservoir
bp	mean annual mortality rate over 13 years; N=177 foxes; Naval Petroleum Reserves in California
bq	N=NR; Buena Vista Valley
br	N=NR; Elk Hills Naval and Buena Vista Petroleum Reserves
bs	time of whelping; N=NR; spring; Tooele County, west. UT, elev. 4300-4800 ft
bt	time of breeding; N=NR; Elk Hills Naval and Buena Vista Petroleum Reserves
bu	based on reproductive condition of adults at time of capture; N=NR; Rand Open Area and Desert Tortoise Research Natural Area
bv	time of juvenile dispersal from natal territory; N=NR; western Utah

References

1 O'Farrell, T.P. 1984. Conservation of the endangered San Joaquin kit fox, Vulpes macrotis mutica, on the Naval Petroleum Reserves, California. Acta Zool. Fenn. 172:207-208.

2 Golightly, Richard T. and Robert D. Ohmart. 1983. Metabolism and body temperature of two desert canids: Coyotes and kit foxes. J. Mammal. 64:624 - 635.

3 Morrell, Stephen. 1972. Life history of the San Joaquin kit fox. Calif. Fish Game. 58(3):162-174.

4 O'Farrell, Thomas P. and Larry Gilbertson. 1986. Ecology of the desert kit fox, Vulpes macrotis arsipus, in the Mojave Desert of southern California. Bull. South. Calif. Acad. Sci. 85(1):1-15.

5 Egoscue, Harold J. 1962. Ecology and life history of the kit fox in Tooele County, Utah. Ecology. 43(3):481-497.

6 Smith, Dwight G. 1978. Notes on ecology and food of the Kit fox in Central Utah. Sociobiology. 3(2):96 - 98.

7 Egoscue, Harold J. 1975. Population dynamics of the kit fox in western Utah. Bull. South. Calif. Acad. Sci. 74(3):122-127.

8 White, Patrick J. and Katherine Ralls. 1993. Reproduction and spacing patterns of kit foxes relative to changing prey availability. J. Wildl. Manage. 57(4):861-867.

9 White, Patrick J., Callie A. Vanderbilt White and Katherine Ralls. 1996. Functional and numerical responses of kit foxes to a short-term decline in mammalian prey. J. Mammal. 77(2):370-376.

10 Paveglio, Fred L and Steven D. Clifton. Oct. 1988. Selenium accumulation and ecology of the San Joaquin kit fox in the Kesterson National Wildlife Refuge Area. Los Banos, CA: U.S. Fish and Wildlife Service, San Luis Wildlife Refuge.

11 Logan, Christopher G., William H. Berry, William G. Standley and Thomas T. Kato. Sep. 1992. Prey abundance and food habits of San Joaquin kit fox (Vulpes velox macrotis) at Camp Roberts Army National Guard Training Site, California. Tupman, CA: EG and G Energy Measurements, Inc., Operations Report No. 10617-2158. 21 p.

12 Scrivner, Jerry H., Thomas P. O'Farrell and Thomas T. Kato. Jun. 1987. Diet of the San Joaquin kit fox, Vulpes macrotis mutica, on Naval Petroleum Reserve #1, Kern County, California, 1980-1984. Tupman, CA: EG&G Energy Measurements, EGG 10282-2168. 26 p.

13 Orloff, Susan, Frank Hall and Linda Spiegel. 1986. Distribution and habitat requirements of the San Joaquin kit fox in the northern extreme of their range. Trans. West. Sect. Wildl. Soc. 22:60-70.

14 Laughrin, Lyndal. 1970. San Joaquin kit fox: its distribution and abundance. Sacramento; CA: California Department of Fish and Game, Wildlife Management Branch Administrative Report. No. 70-2 ed. 20 p.

15 Cypher, Brian L. and Gregory D. Warrick. 1993. Use of human-derived food items by urban kit foxes. Trans. West. Sect. Wildl. Soc. 29:34-37.

16 Hawbecker, Albert C. 1943. Food of the San Joaquin kit fox. J. Mammal. 24(4):499.

17 Cypher, Brian L. and Kenneth A. Spencer. 1998. Competetive interactions between coyotes and San Joaquin kit foxes. J. Mammal. 79(1):204-214.

18 Golightly, Richard T. and Robert D. Ohmart. 1984. Water economy of two desert canids: Coyote and kit fox. J. Mammal. 65(1):51-58.

19 Spiegel, Linda K. and Michael Bradbury. 1992. Home range characteristics of the San Joaquin kit fox in western Kern County, California. Trans. West. Sect. Wildl. Soc. 28:83-92.

20 Daneke, Dennis, Melvin Sunquist and Stephen Berwick. 1984. Notes on kit fox biology in Utah. Southwest. Nat. 29(3):361-362.

21 Zoellick, Bruce W. and Norman S. Smith. 1992. Size and spatial organization of home ranges of kit foxes in Arizona. J. Mammal. 73(1):83-88.

22 Koopman, Marni E., Jerry H. Scrivner and Thomas T. Kato. 1998. Patterns of den use by San Joaquin kit foxes. J. Wildl. Manage. 62:373-379.

23 Egoscue, Harold J. 1956. Preliminary studies of the kit fox in Utah. J. Mammal. 37(3):351-357.

24 Ralls, Katherine and L. Lee Eberhardt. 1997. Assessment of abundance of San Joaquin kit foxes by spotlight surveys. J. Mammal. 78(1):65-73.

25 White, P.J. and Robert A. Garrott. 1997. Factors regulating kit fox populations. Can. J. Zool. 75:1982-1988.

26 Disney, Michele and Linda K. Spiegel. 1992. Sources and rates of San Joaquin kit fox mortality in western Kern County, California. Trans. West. Sect. Wildl. Soc. 28:73-82.